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Hail and Farewell!

This is the twentieth and final number of MALARIA?. The Journal made its appearance at Port Moresby in December 1943. Since then, it has been issued month after month, though the editorial office moved to several bases in New Guinea and the Philippines until this last edition is published at theater headquarters. In its brief span, it has chronicled the decline of malaria in this theater from heights which threatened military operations to levels which represent little more than residual recrudescences of the disease.

The publication has served a worthy purpose and has served it well! In its modest way, it has made known to the entire malaria control organization the observations and activities of the individuals and units which comprise that organization. It has disseminated working knowledge; it has stimulated inventiveness; it has coordinated effort. Thus, it has helped control malaria in the Southwest Pacific.

To the past editors of MALARIA?, their faithful assistants and the contributors whose labor has made possible this journalistic service, the theater owes and tends its grateful thanks.

In the future, material which has appeared in the pages of MALARIA? will be found in the Preventive Medicine Section of the forthcoming Journal of Military Medicine in the Pacific. This publication will be distributed each month, commencing in September, to all malariologists and officers in malaria control and survey detachments. Contributors are invited to send technical and news notes, summaries of parasitologic, entomologic and rodentologic findings and of control activities, accounts of new methods and other materials believed to be of interest and importance to malaria, insect and rodent control personnel to the office of the Chief Surgeon, United States Army Forces, Pacific, APO 500, attention: Chief Malariaologist.

Excerpts from

"Problems in Sanitation and Hygiene"

by

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Nine forms of DDT have been placed on quartermaster supply tables and are available according to the allowances, indicated in War Department Circular 151 and a revision thereof to be published shortly, except for the three newest items added, - the liquid finished spray, the DDT emulsion concentrate and the DDT aerosol dispenser.

The following list indicates the catalog name, QM Stock Number, formula, packaging and primary use of each of these insecticides:

1. Insecticide, powder, louse, 2-ounce can, QM No. 51-I-173, 10% DDT in pyrophyllite, packaged 48 cans to a carton, is intended primarily for individual use in the treatment and prevention of louse infestation.
2. Insecticide, powder, louse (bulk), QM No. 51-I-180, also 10% DDT in pyrophyllite, put up in 5-pound metal containers and packaged six containers to a box, is for use primarily in mass delousing with hand or power dusters. Its uses for control of other insects will be described later.
3. Larvicide, DDT, powder, dissolving, QM No. 51-L-120, a commercial grade of pure DDT put up in 10-pound metal containers packed 4 containers to a box is issued for the preparation in the field of oil solutions for mosquito larvicing, or for making up residual spray and other DDT preparations when the finished product is not available.
4. Larvicide, DDT, powder, dusting, QM No. 51-L-122, 10% DDT in talc, put up in 5-pound metal containers, 8 containers to a box, is designed for use as a dusting powder in mosquito larvicing. It can be used in place of louse powder for mass delousing when louse powder is not available as well as for the control of other insects such as roaches, ants and fleas.
5. Insecticide, spray, DDT, residual effect, QM No. 51-I-305, 5% DDT in refined kerosene, put up in five gallon metal containers and 55 gallon steel drums, is issued primarily for fly and mosquito control and secondarily for the control of a number of other insects, such as fleas, bedbugs, roaches and ants to mention those of military importance. It is designed for application to surfaces upon which insects crawl or rest being applied as a wet spray or with an ordinary paint-brush, and exerting its effect by the prolonged residual action of the DDT deposit. This item probably has the widest usefulness of any of the DDT insecticides and gives long-term control in many instances. However, it should be applied by trained personnel.
6. Insecticide, liquid, finished spray, QM No. 51-I-169, now containing 1% DDT and 2½% thanite in kerosene and put up in 5-gallon metal containers

is for use as a general utility insecticide against all types of insects. It is applied directly to the insects in similar fashion to the common "flit-gun" type sprays. Stocks on hand of the old formula can easily be converted, if desired, by adding an equal amount of refined kerosene plus the necessary amount of DDT for a 1% DDT solution. Labels should be altered to indicate the DDT content.

7. Insecticide, spray, delousing, QM No. 51-L-310, containing 6% DDT, 68% benzyl benzoate, 12% benzocaine and 14% Tween-80, a hydrocarbon solvent, put up in 1-gallon and 5-gallon metal containers, is a concentrate and must be diluted 1 part concentrate to 5 parts water by volume to form an emulsion-type spray. This emulsion is not stable and must be prepared just prior to use and used within 24 hours. It is employed principally in conjunction with fumigation or steam disinfection procedures for delousing and includes an effective scabicidal agent.

8. Insecticide, aerosol, 1-pound dispenser, QM No. 51-I-159, containing 3% DDT, 2% pyrethrum extract (20% pyrethrins), 5% cyclohexanone, 5% hydrocarbon oil and 85% Freon-12, put up in steel cylinders under pressure, equipped with a release valve and packed 24 to a carton is designed primarily for control of adult mosquitoes. The DDT aerosol cylinders are finished in olive drab; the old formula which depended entirely on pyrethrum for its insecticidal activity had its dispenser finished in black.

9. Insecticide, DDT, emulsion concentrate (formerly called Insecticide, DDT, louse-proofing, underwear) QM No. 51-I-95, containing 25% DDT, 10% Triton X-100 and 65% xylene, and put up in 5-gallon metal containers is issued primarily for impregnating underwear to make them louse-proof. It must be diluted 1 part concentrate in 11 parts water to form an emulsion before treating underwear. After dipping and wetting the underwear, excess emulsion is squeezed or wrung out so that the weight of the underwear with the retained emulsion will be approximately twice its dry weight. In this way the recommended dosage of slightly over 2% DDT of the dry weight of the garment will be present in the fabric.

I will take up first, fly control which has acquired prominence in several theaters. The control of houseflies depends on knowing their habits, ruining their breeding places, destroying their larvae and killing the adults. In this, prevention of breeding is the most effective part of a fly-control program. To control breeding places, all human waste, animal manure and garbage must be disposed of or treated promptly and effectively. Powdered borax for the treatment of pit latrines and compost piles will likely be replaced with DDT residual spray. The spraying of refuse piles, latrines and the like will be of considerable value in reducing the fly population. Neighboring native habitations in poorly sanitized areas are also frequently a major source of flies and should receive careful attention if at all possible, thereby allowing greater opportunity for contact action of the DDT. In treating latrines, the walls, ceiling, door and screens, as well as the inside walls of the latrine box, the walls of the pit and the fecal contents should be sprayed. If use of the latrine can be spared until the spray deposit dries, the outside of latrine boxes should be treated also. Present indications are that application of DDT residual spray is much more effective than the previous preparations used to prevent or kill fly larvae breeding in the fecal material of pit latrines when fly-proofing has been inadequate. The use of 2-ounces residual spray per latrine seat hole applied twice weekly at first to the surface of fecal material is suggested. Local experience will determine if larval treatment need be repeated less often.

The extensive use of DDT residual spray in areas with high diarrhea and dysentery rates constitutes an essential part of all fly control programs. Where temperatures are 70° or higher throughout the day and night, PDB (paradichlorobenzene) has been found highly effective also in controlling fly breeding in pit latrines. Experimental work is going on in two theaters as well as in the continental United States to compare the effectiveness of PDB with DDT in this regard.

In mess halls and kitchens where flies are a problem, it is advisable to apply DDT residual spray thoroughly to the walls, doors, screens, ceilings, cross beams, light wires, light cords and similar places. All food, cooking equipment, eating utensils and table tops must be covered before spraying is begun. The application of residual spray with a paint brush to door and window screens alone sometimes will reduce the fly population considerably. However, more thorough application is advised to include walls, ceilings, cross-beams, light cords and the like. Cloth strips soaked in the residual spray and when dry hung from the ceiling similar to present fly-tapes are surprisingly effective. These should not be hung directly over mess tables. Application of residual spray to surfaces at the rate of 200 mg. DDT per square foot will destroy flies for several weeks to several months or more, the duration of effectiveness depending on the type of surface and the degree of exposure of the treated area to weathering. At this rate, a quart of 5% DDT residual spray will cover approximately 250 square feet of surface. The spray should be reapplied when flies begin to show a definite increase in numbers.

When immediate clearance of flies from a room is desired, Insecticide, liquid, finished spray which now contains 1% DDT and 2½% thanite should be used. This is dispersed by means of the ordinary hand "flit" gun just as household type sprays in the past. No special precautions need be taken except to exclude gross contamination of food. Repeated use of this insecticide may in time result in the deposition of sufficient DDT on surfaces to obtain a slight residual action but its use for such purpose would be wasteful.

Coming next to the control of mosquitoes with the DDT insecticides, this use of DDT has greatly simplified mosquito control for the Army and is now playing a large part in keeping the incidence of malaria at a low level in highly malarious theaters. Larvicide, DDT, powder, dissolving, which actually is pure, technical grade DDT, when dissolved in various oils and solvents makes an unusually effective mosquito larvicide, and also an adulticide. The solutions should be mixed and applied by trained personnel indoctrinated in the precautions to observe. Solutions varying from 5% to 0.5% DDT may be used. The concentration may be varied depending on method of application. The important factor is the amount of the active ingredient, DDT, used. It is recommended that oil solutions be applied at such a rate as to give 0.1 to 0.25 pounds of DDT per acre. A 5% DDT solution requires approximately 1 quart per acre, and a 0.5% DDT solution, 2½ gallons per acre at the dose of 0.1 pound DDT per acre.

Since the effectiveness of DDT depends on the material reaching the larvae, sufficient oil should be used to permit coverage. The minimum amount of DDT solution in oil which can be sprayed on an acre and obtain satisfactory results will vary with the type and DDT concentration of the spray available. The amount necessary will also depend on the density of vegetation in the area being treated. In breeding places where the larvae are difficult to reach with a larvicide, heavier applications of DDT should be made. With such heavier

applications considerable residual toxicity to larvae from the DDT may occur even after the oil has evaporated.

DDT oil solutions can be applied by any of the methods used in the past for applying oils alone in larvicing. Pouring solutions from containers such as a bottle, can or bucket where numerous, small, separated areas are to be treated; application by containers of the drip-can type for flowing streams; soaking porous materials such as sawdust, sand or wet gravel and scattering over the water surface, or placing the porous materials in a bag and submerging in ponds; spraying with various types of equipment available -- all are effective means within their proper limitations for larvicing with DDT oil solutions. Drip-cans should be checked frequently since some of the DDT may precipitate out and occlude the openings. Spray is the best method where large and fairly inaccessible areas are to be treated, taking advantage of wind-drift. Nozzles of spraying equipment should be adjusted to give a fine spray depending upon the wind velocity and the area to be covered. Of the types of spraying equipment in the field the C.W.S. decontamination sprayer (Decontamination apparatus, 3-gallon) if available will prove the best. Knapsack sprayers issued by the Corps of Engineers (Sprayer, insect, knapsack types, 5-gallon capacity; Stock No. 41-7839.5-5) are satisfactory but prone to spill solution on the back of the operator unless only partially filled.

In running streams, open roadside ditches, and pools, a 5% DDT in oil solution is advised. Applications to running streams may be made at widely spaced points along the stream allowing the flow of the stream to spread the larvicide. The amount and distances between points of application will vary depending upon stream type, width and rate of flow. For places where drip-cans and porous material soaked in oil have been used in the past suspended over or in streams to apply oils alone, DDT may now be added allowing a reduction in the amount of oil required. In calm waters a small amount should be poured on at different points in the breeding places. A squirt-type oil can will facilitate application where several small places are to be treated. In larger places a lower percentage of DDT and a greater quantity of oil, applied with spray equipment, is recommended.

Coverage can be obtained with smaller quantities of oil in area treatment if a fine spray is developed and advantage is taken of the wind drift as already pointed out. Swaths of 50 to 100 feet or more can be obtained depending upon type of spray, vegetative cover and amount of breeze. This technique will overcome any difficulties that might be encountered caused by the non-spreading of oils. Under suitable conditions, area treatment may be used also where the breeding is in numerous disconnected places, such as for depressions, ruts and hoof prints.

As to effectiveness, an initial larvae kill of 95 per cent or better is obtained from the recommended dosages. One application is usually adequate for 6 to 9 days. Heavier dosages of DDT in moderate to dense vegetation can be expected to give high residual toxicity to mosquito larvae, continuing even after the oil has evaporated. With the heavier applications, the DDT deposited on vegetation (until washed away by rains) will exert a continuing lethal effect to adult mosquitoes who rest thereon. Similarly, the larger doses of DDT in oil spread over water also will kill the adult mosquitoes who have alighted upon the water to deposit eggs. Hence, a very effective dual control -- larvae and adults -- can be achieved persisting 3 to 4 weeks and longer under suitable conditions.

In preparation of new areas for occupation by troops in highly malarious regions the use of DDT oil solutions against adult mosquitoes is an even more important application than their use as mosquito larvicides. For this purpose, spraying of DDT solutions from airplanes has been developed and is ideally suited. This has proven extraordinarily effective and equipment is continually being improved.

Another item which can be used for mosquito control is Larvicide, DDT, powder, dusting, consisting of 10% micronized DDT for use on mosquito larvae as paris green has been used in the past. This powder is a stock mixture from which to prepare the final larvicidal dust by mixing with any available diluent such as pyrophyllite, talc, cement, condemned flour and road dust. A final dust containing from 1 to 5% DDT is suitable for practical application, but 2 per cent is recommended for average conditions. It is applied with hand dusting equipment at a rate of 0.1 pound of active ingredient per acre, and will give practically 100% control for 1 week. The rotary hand duster supplied by the Corps of Engineers is suitable for this purpose.

In thick vegetation, which will prevent shifting of surface dust films from wind and wave action, a residual kill for several weeks to two months after treatment may be expected if larger applications of 1 to 2 pounds of active ingredient per acre are made. Dusts with a percentage of DDT higher than 1 to 5 percent may then be used. In open breeding areas with relatively sparse vegetation, however, it is wasteful to apply more than 0.1 pound of DDT per acre since the treatment may become ineffective within a week due to this shifting of surface film. The time for additional treatments must still be based on dipping records.

The use of Insecticide, DDT, residual effect for adult mosquito control is a highly effective long-term measure similar in effectiveness to that described for flies. When used in mosquito control, it is necessary to spray thoroughly the walls, doors, ceilings, screens and other places in buildings, hutments or tents where mosquitoes are prone to rest. Dark corners or other portions of sleeping quarters where mosquitoes are seen to rest in large numbers should receive an extra heavy spray application. In malarious regions, native habitations within a radius of at least one mile of perimeter of the cantonment area should receive a residue spray treatment, and this may well precede spraying of military installations to kill infected mosquitoes at the source. Certain species, especially some of the anopheline mosquitoes, also rest in out-buildings such as barns, chicken houses, and privies, and fly into human dwellings at night to feed, making it necessary to treat such buildings also. These, as well as mosquitoes that rest on the walls of living quarters either before or after feeding, will then be killed by contact with the DDT on the treated surfaces.

An outdoor use is also suggested. For encampments, outdoor theaters and other assembly places surrounded by dense vegetation in areas where the percentage of malaria infested mosquitoes is high apply the residual spray to all the vegetation in a 50-foot or wider band encircling the area to be protected. Experimentally this type of treatment has been found to cause up to a 95% decrease in the number of mosquitoes in the protected area up to a week and even longer. The duration of effectiveness will vary with the amount of rainfall, since rain will eventually wash the DDT deposit off of the vegetation. The use of a vehicle for the DDT with greater viscosity than kerosene may prolong its effectiveness. This barrier treatment is well worthwhile trying. Reports concerning its effectiveness under field conditions will be appreciated.

The use of DDT residual spray offers an efficient and easy procedure for continual destruction of mosquitoes over prolonged periods of time, and from the preventive medicine viewpoint is a highly important use of DDT in destroying mosquitoes infected with malaria, yellow fever, filaria and dengue.

The aerosol insecticide dispenser has already carved a secure place in the insect control armamentarium against mosquitoes. This handy self-discharging, dispenser has proved invaluable to troops in highly malarious theaters for adult mosquito control. The addition of 3% DDT makes this insecticide even more effective. It is suited for use in all types of enclosures -- barracks, billets, pup-tents, bomb-shelters, trenches, foxholes and the like. The insecticide is released in almost gaseous form (aerosol) which pervades the whole atmosphere in contrast to the ordinary sprays, and remains in a still atmosphere from 2 to 4 hours, thus giving continued protection against additional insects coming into the enclosure after time of application. Due to a scarcity of pyrethrum flowers the distribution of this item has had to be limited to overseas theaters and ships hospitals. In the continental United States it is used only in disinsectization of aircraft to comply with quarantine requirements, and a few are made available for training purposes.

The item, Insecticide, liquid, finished spray, is a general utility spray completes the array of DDT insecticides available for mosquito control.

The control of other flying insects such as sand flies, midges, gnats, punkies and dog flies (*Stomoxys calcitrans*) whose breeding places may be impracticable to destroy can be controlled by the application of the DDT residual spray (Insecticide, DDT, residual effect). Residual spray applied to screens and the outside of buildings and tents will usually reduce the number of such insects which may gain entrance. Application to the interior of the quarters as well will further enhance the effectiveness of control. The spraying of mosquito nets will fortify the protection afforded by such equipment.

The control of lice is of special importance, particularly under combat conditions, because of the seriousness of the disease, epidemic typhus, relapsing fever and trench fever, which they transmit. Due to the development of highly satisfactory prophylactic measures, the disinfestation of troops has not presented any great problem during this war. For both the treatment of lousiness and the prevention of further infestation the application of DDT louse powder is the method of choice. For individual use, the 2-ounce cans of louse powder are available. For mass delousing of either troops or civilians with power dusting equipment, louse powder in bulk (10-pound cans) is available. In the latter, disrobing of the individual is not necessary for application of the powder. Dusting is accomplished by means of compressed air equipment (Outfit, delousing, gasoline engine driven) and a special dusting gun we have developed. This equipment is supplied by the Quartermaster.

Disinfestation of head lice or crab lice may be accomplished by dusting louse powder into the hair of the head or of the body, allowing to remain for 24 hours, and repeating twice at intervals of one week. The powder is not effective against eggs -- hence the necessity for re-application.

Residual spray is useful in controlling lice if applied to the floors and lower walls of quarters and of conveyances such as trucks, coaches and troop compartments of ships. Seats, bunks and other furnishings should also be treated.

Residual spray applied in this way will also be effective against bedbugs, fleas and other non-flying insects at the same time.

For use in delousing centers such as have been established in continental U. S. Ports of Embarkation and overseas, there is available the delousing spray (Insecticide, spray, delousing) which may be safely sprayed on the hairy parts of the body and on the head. This insecticide is employed following the bath required in the fumigation or steam sterilization methods of disinfestation. The spray is both lousicidal and ovicidal and is also an effective scabicide when applied to the skin. Detailed instruction for the use of the delousing spray have been furnished ports of embarkation and fumigation and bath units and will also be included in the forthcoming manual or TB Med on the DDT insecticides.

For control of bedbugs DDT residual spray bids fair to entirely replace fumigation methods. The application of 4 to 6 ounces of residual spray per bed, including springs and mattress, will completely eradicate bedbug infestation for 6 or more months. Approximately 1 quart of the solution should be used for every 5 beds and mattresses. Spraying will be facilitated by placing mattresses 8 high along the middle of the floor and standing the beds on end against the wall with the underside facing inward. In treating beds, application of the spray should be to the underside, paying attention to favorable hiding places, and allowing the surplus spray to fall on the wall behind the beds. In spraying mattresses, particular emphasis should be placed on treating all seams, crevices and tufts. For expeditious handling a team of two men is recommended -- one to do the spraying, the other to turn over and remove each mattress after spraying. If no spraying equipment is available, application of the solution by means of a paint brush is satisfactory. A slight moistening of the surface is all that is required. The insecticide acts slowly, but when the above procedure is followed all bedbugs will be dead in 24 hours as a rule. No smoking or fires should be allowed in the quarters during spraying and the barracks should be aired out completely following the treatment. Operating personnel should be required to wear suitable masks or respirators while in the barracks being treated.

Roaches and ants may be controlled by the 5% DDT residual spray or a 10% DDT powder. A thorough application of DDT residual spray will give several weeks' or more protection from roaches or ants. The duration of the effect will depend to some degree on how quickly the residue is removed by the daily cleaning of the messhall.

The residual spray is preferred for roach control work because treatment for control of flies and mosquitoes can be accomplished at the same time. It is applied by ordinary hand sprayers or power sprayers to such resting and hiding places of roaches as under serving tables, sinks, cupboards, refrigerators, around water pipes and hot water tanks, and into cracks and crevices of the wall. It will be found that the German cockroach is more resistant than the American cockroach and an increase in dosage over 200 mg. DDT per square foot when applying the residual spray may be necessary to effect its control.

For control of ants residual spray may be applied to nests, doorsills, window-sills, foundation and other places where ants crawl. Lawns or grass plots where ants are prevalent can be treated with residual spray with the likelihood of better coverage and more prolonged action due to improved adherence of the DDT deposits to the grass, than when using DDT powder.

The 10% DDT powder (Larvicide, DDT, powder, dusting) for roach and ant control is applied lightly with an ordinary hand-operated dust gun. Not over 10 pounds of powder is necessary to treat the largest messhall. Application is made to the same locations one would apply residual spray. The powder is less desirable than the residual spray because it is more readily removed in cleaning.

Fleas, important as vectors of bubonic plague and endemic typhus fever, are best controlled with DDT by treating infested human dwellings as well as the occupants and pets. In conjunction with rodent control programs, DDT louse powder or DDT residual spray may be applied to the floor and lower parts of the walls of infested quarters. Dosages of 200 mgm. of DDT per square foot are advised. On earthen floors the dosage must be considerably greater. Louse powder should be used for the occupants and pets and may be applied by the same individual and mass delousing methods applicable in the control of lice to prevent epidemic typhus.

As for mites or chiggers, these breed in areas of vegetation and feed on rodents at a certain stage of their development. In addition to individual protective measures, control should be directed toward clearing camp areas of vegetation as well as toward the extermination of rodents. Heavy DDT spraying or dusting of the ground around beds and in the camp area may prove effective in eradicating mites but has not been fully evaluated as yet. For individual protection the wearing of dimethyl phthalate impregnated clothing is now used for temporary protection of troops operating in mite infested areas.

In control of ticks the DDT preparations have not been found to be particularly effective and their use for this purpose cannot be recommended. The use of the standard triple-mixture repellent is the best measure available for individual protection against ticks. The wearing of clothing impregnated with an emulsion of dimethyl phthalate or sprayed with dimethyl phthalate also will give partial protection.

I have felt that the matter of toxicity of the DDT insecticides should be discussed with you also at this time, if only to indicate the precautions to be observed. It should be pointed out that although DDT can be handled safely it is nevertheless a toxic material. Personnel should be trained thoroughly in the application of the DDT insecticides and the precautions to observe, and should not be allowed to disregard precautions recommended.

Symptoms of DDT poisoning in laboratory animals are loss of appetite, weight loss, hyperexcitability, tremor and finally convulsions. Disfunctioning of the liver and kidneys may precede the onset of nervous system manifestations. An increase in the prothrombin time paralleled by a rise in the icterus index were noted in one instance followed by an increase in the urinary output to several times its normal volume. These findings plus a moderate leukocytosis occurred prior to the onset of nervous symptoms. When tremors first appeared they were coarse in nature, involved the entire musculature, and were particularly marked in the legs upon standing and in the muscles over the eyes. The tremors decreased when DDT was withdrawn for a day. Animals given DDT until a fatal termination show a toxic necrosis of the liver and kidneys frequently enough to be significant. Most of these animals show some evidence of degeneration of the anterior motor neurons of the spinal cord. Other organs are essentially negative.

Toxicity for man must be deduced from these animal experiments since no proven case of DDT toxicity in man has occurred. Three individuals subjected accidentally or otherwise to extraordinary amounts of DDT in the course of their work were carefully examined and observed for an extended period to note any variations from the normal. Repeated physical, neurological and laboratory examinations revealed no symptoms or signs of untoward effect from their exposure to DDT. While these findings were not considered conclusive they did indicate a certain degree of tolerance for DDT on the part of human beings.

Any individual using DDT insecticides in the field and suspected of displaying evidence of toxicity to DDT should be removed from further contact and placed in a hospital with adequate facilities for making a careful and complete examination including neurological and repeated liver and kidney function tests. Report of such study should be forwarded upon completion to the Preventive Medicine Service, Office of the Surgeon General, to add to the present knowledge concerning toxicity for man. If possible, information should also be furnished concerning the following:

- (1) DDT insecticide employed.
- (2) Estimate of amount of DDT contacted.
- (3) Manner of contact -- skin absorption, ingestion or inhalation.
- (4) Duration of contact.
- (5) Any other factor of significance.

Dry DDT as used in inert powders and dusts is not absorbed through the skin nor is it readily absorbed when injected subcutaneously or intramuscularly. The use of 10% DDT louse powder in conjunction with insect repellent, though, is not recommended. Repellents are solvents for DDT which then can be absorbed through the skin. If underwear dusted with louse powder are accidentally and grossly contaminated with oil, they should be changed and the contamination area of the skin washed with soap and water.

Inhalation of 10% DDT powder as normally used in the field will not produce any toxic effects as indicated by laboratory studies and corroborated by the large scale typhus control dustings in Italy. Yet, it might be wise for operators engaged in mass delousing or large scale dust larvicing to use suitable respirators or dampened gauze masks when dusting indoors or under conditions where the atmosphere does not carry the dust cloud away from them.

By mouth, DDT is acutely toxic to laboratory animals. Because of wide variation in individual susceptibility, the determination of a safely tolerated dose is extremely difficult. The upper limit of tolerance in dogs on daily ingestion of dry DDT powder appears to lie between 50 - 100 mg. per kilo per day; tolerance in some of the other smaller animals is considerably less. Moreover, when the same dosages are given dissolved in corn oil, tolerance is reduced over 50 per cent. Hence, care should be taken to prevent contamination of food. This is especially important because DDT is a whitish, odorless and tasteless powder bearing a physical resemblance to flour and offers no warning upon ingestion. All foodstuffs, cooking utensils, eating utensils and tabletops must be covered when dispensing DDT in any form in messhalls. Storage of DDT with food should be strictly prohibited in order to prevent mistaken identity.

Solutions of DDT in oils and organic solvents can be absorbed through the skin making it necessary to avoid unnecessary contamination of garments and skin. Coveralls and suitable gloves should be worn when mixing and dispensing such solutions. Occasional contact is apparently not dangerous but prolonged contact must be avoided. When individuals accidentally contaminate themselves they should change their clothes, including DDT dusted or impregnated underwear, as soon as practicable and wash their body thoroughly with soap and water. To reduce the possibility of contamination in dispensing such solutions, paint sprayers and the decontamination type sprayer are preferable to the knapsack type. When knapsack sprayers are employed they should not be more than three-quarters full to prevent spilling.

Continued inhalation of oil or kerosene sprays containing 5% or more of DDT may produce toxic effects since absorption of DDT from the respiratory tract is facilitated by such solvents. In this connection, it has been shown that solution of DDT in fatty oils increases its toxicity from inhalation over that observed when dissolved in an organic solvent such as cyclohexanone. While dispensing Insecticide, spray, DDT, residual effect (5 per cent DDT in kerosene) indoors for prolonged periods as for treating walls, ceilings, fixtures, beds, mattresses and the like, suitable respirators or cloth masks should be worn by the operators. Procurement of a new formula for Insecticide, liquid, finished spray containing 1% DDT and 2 $\frac{1}{2}$ % thanite in kerosene instead of the present 5% thanite in kerosene was recently initiated. No special precautions need be taken in the normal use of this latter spray other than those which will exclude the gross contamination of food. Rabbits were exposed to a heavy mist of 1% DDT in kerosene 48 minutes daily for four weeks without toxic effect.

By mouth, DDT preparations in oils and organic solvents exert considerably greater toxic effect than in powder form. The ingestion of 50 to 80 mg. per kilo per day in a solution of corn oil causes fatal poisoning in dogs in three to five weeks. Hence, operators should take precautions similar to those prescribed in dispensing DDT as a powder to prevent contamination of food when spraying in mess halls. DDT solutions should not be stored with foodstuffs.

As for DDT in aerosols, the concentration of DDT in the atmosphere when dispensed according to instructions (4 seconds per 1000 cubic feet) in a 1 to 5% DDT aerosol formula is exceedingly small and can be breathed under the normal conditions of its use without ill effect. A 3% DDT aerosol will give approximately 0.06 mg. DDT per cubic foot at the above dosage. Exposure of dogs, rats and guinea pigs to initial concentrations respectively of 54.4, 12.44 and 6.22 mg. of DDT per liter of air over a period of 45 minutes caused no toxic signs or symptoms. Chronic toxicity studies demonstrated that exposure of monkeys for 2 hours and 15 minutes daily for four weeks and mice for 45 minutes daily for 5 weeks to a concentration of 0.176 mg. DDT per liter of air (5.0 mg. per cubic foot) produced no toxic effect. Daily exposure of human subjects for 1 hour to a concentration of 1.0 mg. DDT per cubic foot showed that a 1 to 5% DDT aerosol offers no health hazard under conditions required for its use. It was further found that the DDT in the atmosphere settles out fairly soon.

Underwear impregnated with a DDT emulsion prepared from Insecticide, DDT, emulsion concentrate were worn in field tests for periods from 1 to 4 months without toxic effect or irritation of the skin, and retained their lousicidal effect during that time. The only potential hazard involved when they are worn is to personnel handling fuel or lubricating oils. Spilling of oil on the

underwear may bring the DDT into solution again which could then be absorbed through the skin. Changing to another pair of underwear, and a bath with soap and water will prevent any ill effect. Personnel engaged in impregnating underwear with DDT emulsions in the field should avoid dipping their arms in the prepared solutions or handling the wet garments with bare hands when wringing them out and hanging them up to dry. Ladles or tongs of some sort should be provided for immersing the underwear, and preferably rubberized gloves for the operators' hands.

The 1% DDT emulsion used as a delousing spray to hairy parts of the body and prepared from the stock of mixture, Insecticide, DDT, spray, delousing by diluting with five parts of water was submitted to toxicity tests and found safe to apply to the skin. Since the stock mixture contains 6% DDT personnel preparing the final solution should take ordinary precautions to avoid contaminating their hands with the stock mixture. Good ventilation should be provided and rotation of operating personnel is recommended when spraying for long periods indoors.

In a comprehensive statement the toxicity of DDT may be summarized as follows:

"The DDT insecticides adopted for use can be safely employed, but it must not be overlooked that DDT is a toxic material. In general, inhalation of dusts, sprays or mists containing DDT should be reduced to a minimum. Whereas dry DDT as used in inert powders is not absorbed through the skin, solutions of DDT in oils and organic solvents can be absorbed through the skin and, therefore, unnecessary skin contact should be avoided. For this reason, use of repellents in conjunction with DDT louse powder is not advised; and garments, including DDT dusted or impregnated underwear, accidentally contaminated with oils in the presence of DDT should be changed as soon as practicable, the individual washing himself thoroughly with soap and water. Contamination of food with DDT must be prevented. This is especially important because DDT is a white, odorless and tasteless powder and offers no warning upon ingestion. Storage with food should be strictly prohibited to prevent mistaken identity. Symptoms of DDT toxicity in animals are anorexia, weight loss, hyperexcitability, tremor and convulsions. Signs of liver and kidney dysfunction may precede nervous manifestations. Pathological findings in fatal poisoning induced in animals consist in some evidence of degeneration of the anterior motor neurons, and may include toxic necrosis of the liver and kidneys."

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